Regulation of Metabolic Pathways

- **Limited number of regulatory enzymes**
  - **Negative feedback**

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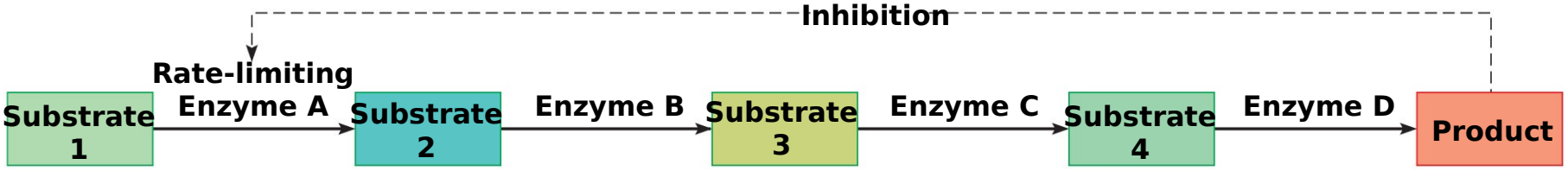

4.4: Energy for Metabolic Reactions

- **Energy is the capacity to change something; it is the ability to do work**
- **Common forms of energy:**
  - **Heat**
  - **Light**
  - **Sound**
  - **Electrical energy**
  - **Mechanical energy**
  - **Chemical energy**

ATP Molecules

- **Each ATP molecule has three parts:**
  - **An adenine molecule**
  - **A ribose molecule**
  - **Three phosphate molecules in a chain**

Third phosphate attached by high-energy bond

When the bond is broken, energy is transferred

- **When the bond is broken, ATP becomes ADP**
- **ADP becomes ATP through phosphorylation**
  - **Phosphorylation requires energy release from cellular respiration**

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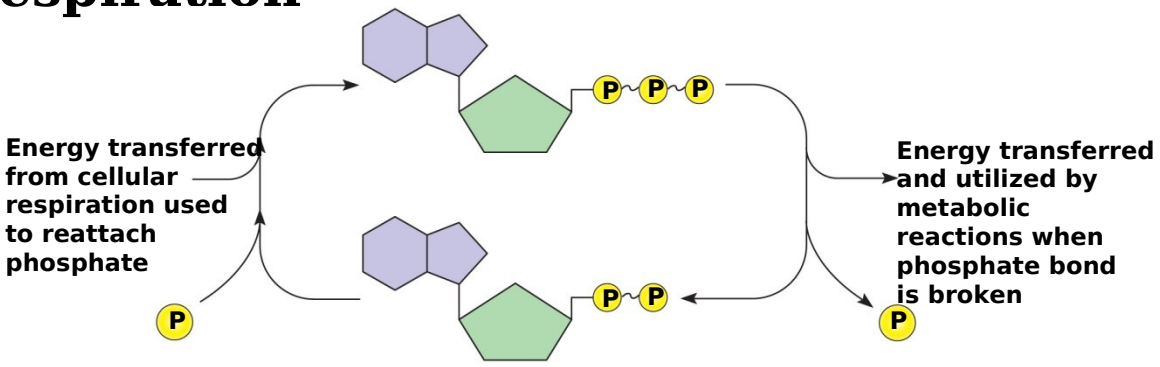

Release of Chemical Energy

- **Chemical bonds are broken to release energy**

- **We burn glucose in a process called oxidation**

4.5: Cellular Respiration

- **Occurs in a series of reactions:**
  1. **Glycolysis**
  2. **Citric acid cycle (aka TCA or Kreb's Cycle)**
  3. **Electron transport system**

Cellular Respiration

- **Produces:**
  - **Carbon dioxide**
  - **Water**
  - **ATP (chemical energy)**
  - **Heat**

- **Includes:**
  - **Anaerobic reactions (without O_2) - produce little A**
  - **Aerobic reactions (requires O_2) - produce most AT**

Glycolysis

- **Series of ten reactions**
- **Breaks down glucose into 2 pyruvic acid molecules**
- **Occurs in cytosol**
- **Anaerobic phase of cellular respiration**
- **Yields two ATP molecules per glucose molecule**

ummarized by three main phases or events:

1. **Phosphorylation**
2. **Splitting**
3. **Production of NADH and ATP**

Glycolysis

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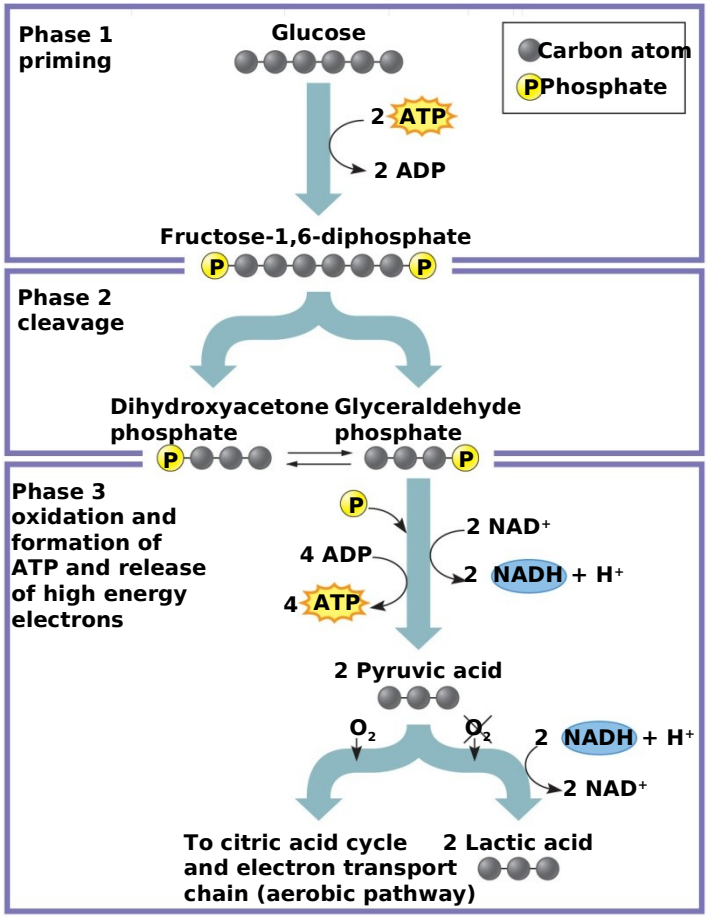
Event 1 – Phosphorylation

- **Two phosphates added to glucose**
- **Requires ATP**

Event 2 – Splitting (cleavage)

- **6-carbon glucose split into two 3-carbon molecules**



Glycolysis

Event 3 – Production of NADH and ATP

- **Hydrogen atoms are released**
- **Hydrogen atoms bind to NAD^+ to produce NADH**
- **NADH delivers hydrogen atoms to electron transport system if oxygen is available**
- **ADP is phosphorylated to become ATP**
- **Two molecules of pyruvic acid are produced**
- **Two molecules of ATP**

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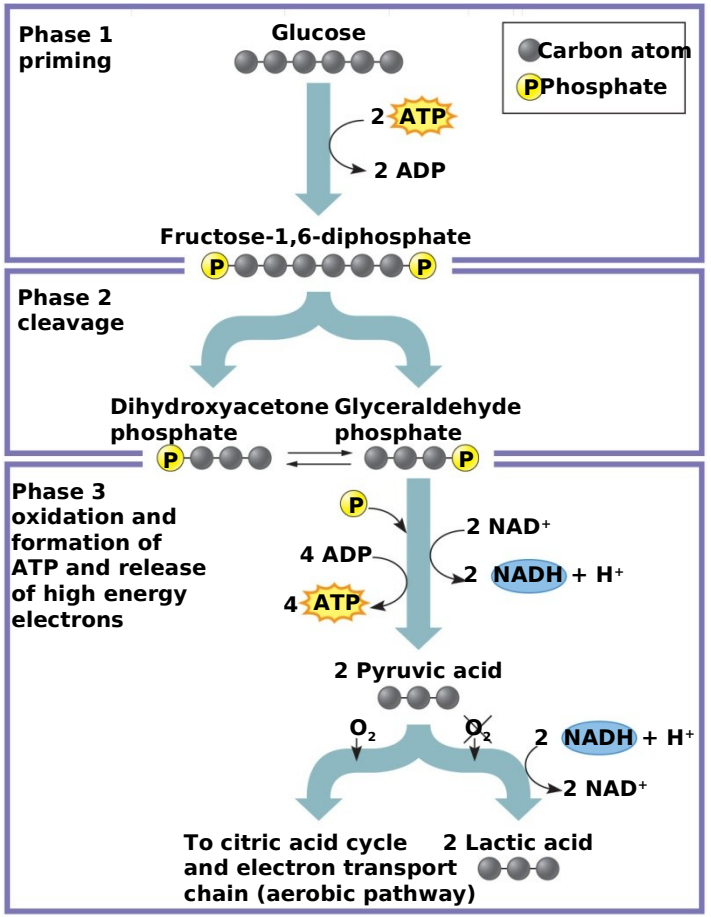

Anaerobic Reactions

- **If oxygen is <u>not</u> available:**
  - **Electron transport system cannot accept new electrons from NADH**
  - **Pyruvic acid is converted to lactic acid**
  - **Glycolysis is inhibited**
  - **ATP production**

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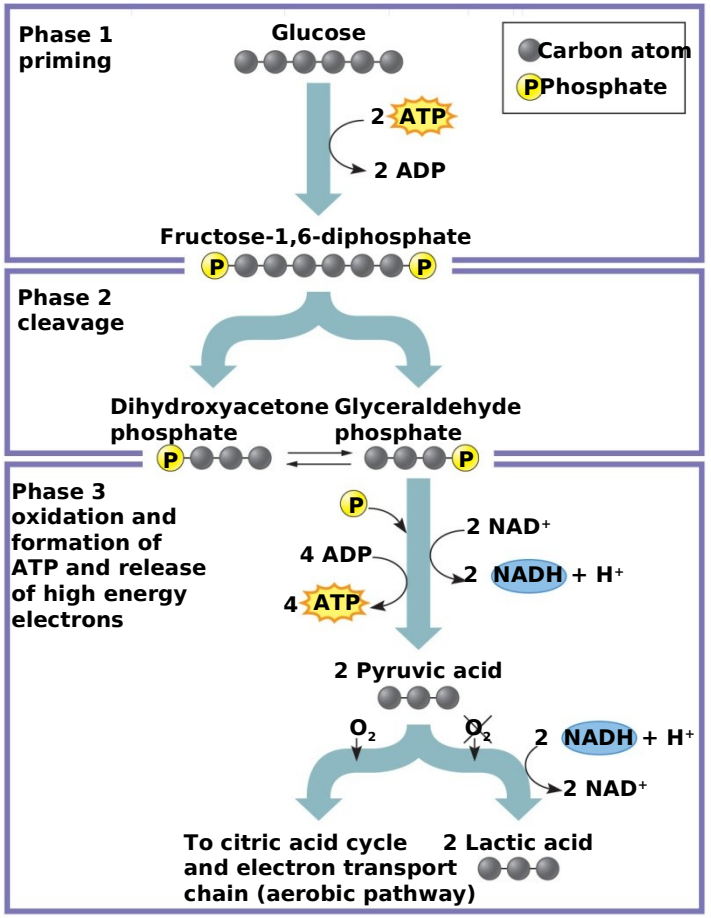

Aerobic Reactions

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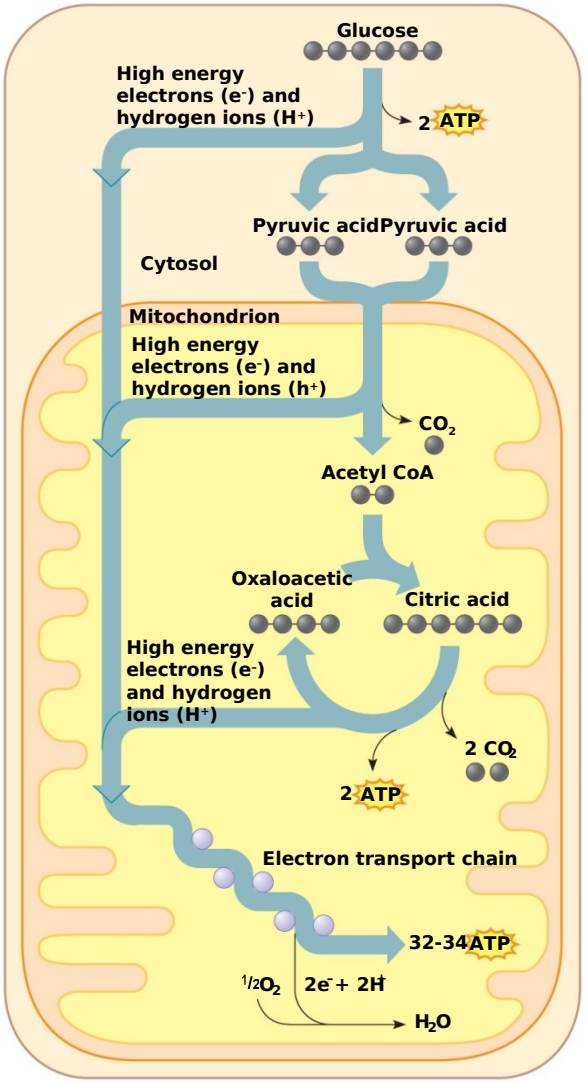
- **If oxygen <u>is</u> available:**
  - **Pyruvic acid is used to produce acetyl CoA**
  - **Citric acid cycle begins**
  - **Electron transport system functions**
  - **Carbon dioxide and water are formed**
  - **34 molecules**



Citric Acid Cycle

- Begins when acetyl CoA combines with oxaloacetic acid to produce citric acid
- Citric acid is changed into oxaloacetic acid through a series of reactions
- Cycle repeats as long as pyruvic acid and oxygen are available
- For each citric acid molecule:
  - One ATP is produced
  - Eight hydrogen atoms are transferred to NAD^+ and FAD

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